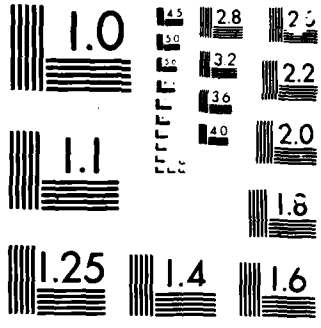
AD-A166 971 A MODULAR AMPLIFIER FOR MINI-TEA (TRANSVERSELY EXCITED ATMOSPHERIC) LASERS(U) ARMY ELECTRONICS RESEARCH AND DEVELOPMENT COMMAND FORT BELVOI.. J A FOX OCT 82 1/1

UNCLASSIFIED F/G 20/5 NL



MICROCOPY CHART

FINAL REPORT

TITLE: A Modular Amplifier for Mini-TEA Lasers

INVESTIGATOR: Jay Fox

In October, 1982 a project was initiated to demonstrate the feasibility of constructing optical CO_2 amplifiers that could be easily attached to low power oscillators in order to increase the output. As the following documentation shows, some success was realized in that significant increases in peak power were observed and therefore feasibility was established. Due to higher priorities, other schemes for increasing output power were pursued and this work was terminated at the end of FY83.

Source: Night Vision and Electro-Optics Center, Fort Belvoir, VA 22060

PROJECT APPRAISAL

TITLE/INVESTIGATOR: A Modular Amplifier for Mini-TEA Lasers/Jay A. Fox

START (Mo/Yr)	$K(Cum)	FY83 OBJECTIVE ATTAINED	SCIENTIFIC RESULTS
Oct 82	60	YES	GOOD

OBJECTIVE: To show feasibility of constructing multi-pass optical CO_2 amplifier modules that can easily be attached to existing low power (i.e. rangefinder) oscillators.

RELEVANCE: Transversely Excited Atmospheric (TEA) lasers operating at the 10.6 um wavelength are presently under development for military use in transmitters for rangefinders, crosswind sensors, target designators and target intensifiers. Each of the functions requires different laser parameters. For example, it requires 2 to 3 times as much energy to perform crosswind sensing as it does for rangefinding, while a target designator may need up to 10 times the output of a rangefinder. In addition, the pulse shape for each task may not be the same. Since laser output scales roughly with volume, a single device capable of meeting all requirements would be much larger than necessary for, say, rangefinding. On the other hand, it might not be economically feasible to develop separate lasers for each task. Modular amplifiers offer a possible alternative.

APPROACH: A TEA laser oscillator will be constructed along with a single and then a triple laser pass amplifier section. The purpose of the phase of the work will be to measure the gain in this section, determine the best preionization scheme and to establish voltage and current requirements. From these results the feasibility of constructing an amplifier with a gain of at least five times will be determined. If feasible, the construction and testing of such a unit will commence in FY84.

ACCOMPLISHMENTS: Both a single and triple pass oscillator-amplifier have been constructed and tested. Various preionization schemes were considered and a series-connected sliding arc arrangement proved to most satisfactory. Power, energy and gain measurements were taken as well as voltage and current waveforms. Significant increases in peak power were observed (>2.5 times) and a ten percent pulse narrowing was measured. The feasibility of constructing the desired device has been established.

All milestones for the period have been met.

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I. BACKGROUND/RELEVANCE

Transversely Excited Atmospheric (TEA) lasers operating at the 10.6 um wavelength are presently under development for military use in transmitters for rangefinders, crosswind sensors, target designators and target intensifiers. Each of these functions requires different laser parameters. For example, it requires 2 to 3 times as much energy to perform crosswind sensing as it does for rangefinding, while a target designator may need up to 10 times the output of a rangefinder. In addition, the pulse shape for each task may not be the same. For example, in certain proposed target identification schemes, a long duration pulse is desirable, while for rangefinding this requirement may be a hindrance. To complicate matters yet further, there are other applications for pulses much shorter than even the rangefinder requirement.

Even if the pulse shape requirements were not important, the energy consideration would still pose a problem. Since laser output scales roughly with volume, a single device capable of meeting all requirements would be much larger than necessary for, say, rangefinding. Why should a vehicle (much less a single soldier) carry around a unit ten times as large as necessary when all that needs to be accomplished is rangefinding? On the other hand, it might not be economically feasible to develop separate lasers for each task. A possible alternate approach is suggested in this proposal.

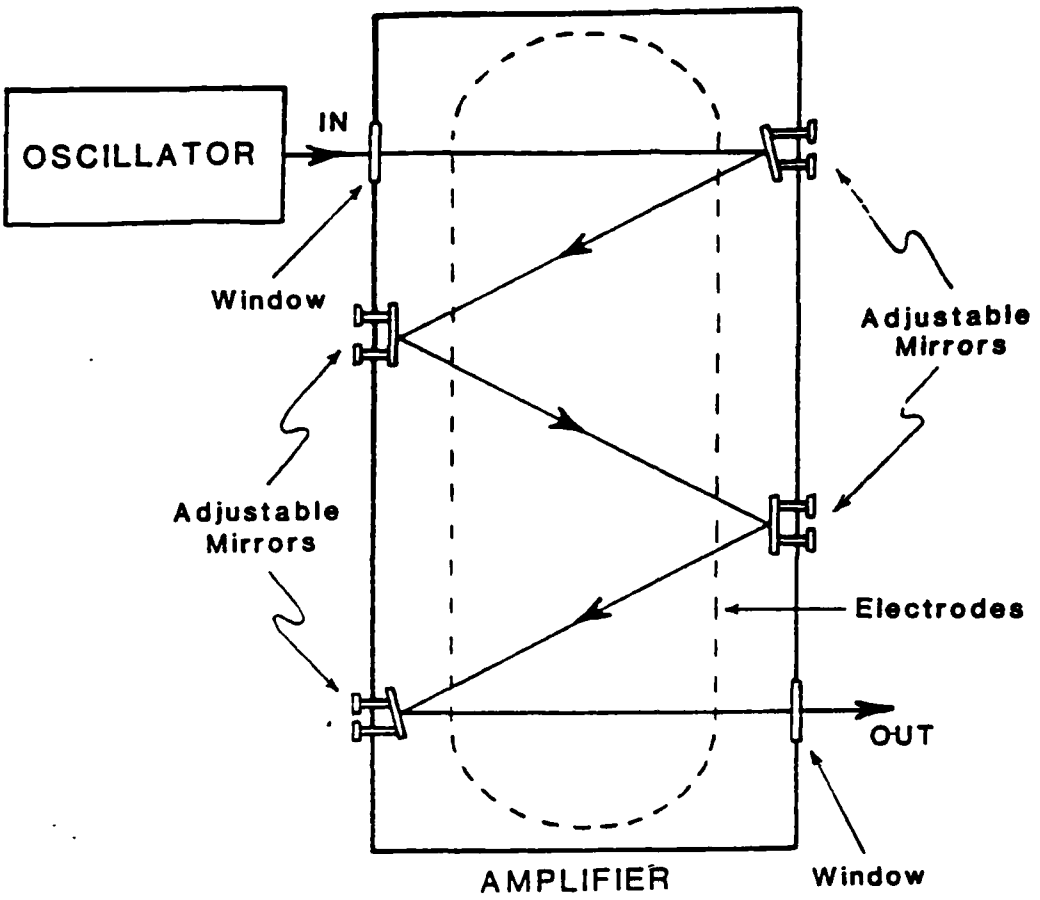
II. OBJECTIVE

The objective of this investigation is to demonstrate that some or all of the various requirements can be attained via the modular approach. Specifically, the aim of the proposed research is to show the feasibility of constructing multi-pass optical amplifier modules that can be easily attached to existing low power (i.e. rangefinder) oscillators. Thus, when a particular function is to be performed, the rangefinder transmitter can be quickly transformed into, for example, a crosswind sensor or a designator transmitter. In addition, as will be discussed later, this device would also allow the modification of the pulse shape.

III. APPROACH

It should be made clear that what is being proposed is not just a simple extension of the resonant optical cavity. Clearly, a device ten times as long as the present rangefinder transmitter would be unacceptable. Also, it is easy to reject a folded ten-pass oscillator system. Such a unit would be virtually impossible to align manually and quite sensitive to misalignment in the field. In addition, no additional control over pulse shape is possible with this oscillator.

On the other hand, consider the multi-pass amplifier system shown here.



Since the amplifier is not part of a resonant cavity, it is relatively insensitive in alignment. (Indeed, it is much less so than the laser rangefinder oscillator itself.) In principle, this (or other) module(s) could easily bolt onto existing rangefinder transmitters and thus be immediately available for other tasks. In addition, it is well-known that amplification also shortens the pulse duration. There is also evidence that operation at above atmospheric pressure would enhance this effect as well as boost power. It might even be possible to select a specific laser spectral line for amplification by incorporating a grating within the amplifier. Further changes could be effected by suitably modifying the gas composition of the amplifier module.

IV. RESEARCH AND PUBLICATION PLAN

A literature search, which has already begun, will be conducted with the goal of identifying previous work in the area of amplification of TEA laser pulses. It is anticipated that research in the CO_2 laser fusion program has produced considerable information that will prove useful in this investigation.

A TEA laser oscillator will be constructed along with a single (and perhaps double) pass amplifier section. The purpose of this phase of the work will be to measure the gain in this system and to determine the optimum gas mix as well as the voltage and current requirements. If possible, the saturation intensity will also be measured. From this information, the number of passes required to construct an amplifier with gain of a factor of at least 5 will be calculated. Preliminary calculations indicate that 3 to 5 passes through a 20 cm long section should yield gains in this range. This calculation may be optimistic, however, since it assumes no saturation. At any rate, a more realistic estimate will be made after the preliminary amplifier experiments have been conducted. Also, during this period, the type preionization to be used in the multipass amplifier will be decided and a decision will be made concerning the feasibility of using single of multiple pairs of electrodes in the multipass system.

If these preliminary results indicate there is a reasonable probability of success, the multipass system will be constructed. The gain in each section will be measured and the output characterized as to energy, peak power, spatical distribution and pulse shape. Assuming success at this point, the pressure will be raised and measurements of the same parameters will be taken.

Apparently, little or no work has been done in the area of multipass, compact amplifiers for small TEA lasers. Therefore, it is reasonable to expect that at least one publication and presentation will result from this effort. In addition, a patent application may be made.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY				1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
				DA 30 09 09	83 08 17	DD-DR&E(AR) 636
3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY	6. WORK SECURITY	7. REGRADING	8. DISP'N INSTR'N	9. LEVEL OF SUM A. WORK UNIT
82 10 20	D. Change	U	U			

10. NO./CODES:	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	61101A	1L161101A91A	GG	
b. CONTRIBUTING				
c. CONTRIBUTING	STO: 82-3:2			

11. TITLE *(Precede with Security Classification Code)*

12. SUBJECT AREAS

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING ORGANIZATION	16. PERFORMANCE METHOD
	84 09		

17. CONTRACT/GRANT		18. RESOURCES ESTIMATE		
a. DATE EFFECTIVE	EXPIRATION	FISCAL YEARS	a. PROFESSIONAL WORKYEARS	b. FUNDS *(In thousands)*
b. CONTRACT/GRANT NUMBER				
c. TYPE	d. AMOUNT	83	0.5	25
e. KIND OF AWARD	f. CUM/TOTAL			

19. RESPONSIBLE DOD ORGANIZATION	20. PERFORMING ORGANIZATION
a. NAME	a. NAME
b. ADDRESS *(include zip code)*	b. ADDRESS
c. NAME OF RESPONSIBLE INDIVIDUAL	c. NAME OF PRINCIPAL INVESTIGATOR
d. TELEPHONE NUMBER *(include area code)*	d. TELEPHONE NUMBER *(include area code)*
21. GENERAL USE FOREIGN INTELLIGENCE CONSIDERED MILITARY/CIVILIAN APPLICATION	f. NAME OF ASSOCIATE INVESTIGATOR *(if available)* g. NAME OF ASSOCIATE INVESTIGATOR *(if available)*

22. KEYWORDS *(Precede EACH with Security Classification Code)*

23 TECHNICAL OBJECTIVE 24 APPROACH 25 PROGRESS *(Precede text of each with Security Classification Code)*

25. (U) 82 10 - 83 08 Both a single and triple pass oscillator/amplifier combination have been constructed and tested. Various preionication schemes were tested and a series-connected sliding arc arrangement was selected. Power, gain and energy as well as voltage and current waveforms have been measured. Significant increases in peak power were obtained (>2.5 times) and a ten percent pulse narrowing was also measured.

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